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ACCESS TO AFFORDABLE ENERGY IN RURAL AREAS IN THE ARAB REGION

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ACRONYMS

AC	Alternating Current
ADB	Asian Development Bank
ADFD	Abu Dhabi Fund for Development
AfDB	African Development Bank
AFED	Arab Forum for Environment and Development
AFESD	Arab Fund for Economic and Social Development
AMF	Arab Monetary Fund
AusAID	Australian Agency for International Development
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CO_2	Carbon Dioxide
CSP	Concentrated Solar Power
CTF	Clean Technology Fund
DC	Direct Current
EC	European Commission
EE	Energy Efficiency
EIB	European Investment Bank
ESCWA	Economic and Social Commission for Western Asia
EUR	Euro Currency
FDI	Foreign Direct Investment
GCC	Gulf Cooperation Council
GCCA	Global Climate Change Alliance
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gas
GNI	Gross National Income
IBRD	International Bank for Reconstruction and Development
ICI	International Climate Initiative

IDA	The International Development Association
IEA	International Energy Agency
IFAD	International Fund for Agriculture Development
IFC	International Finance Corporation
JICA	Japan International Cooperation Agency
KAUST	King Abdullah University of Science and Technology
KFAED	Kuwait Fund for Arab Economic Development
KfW	German Development Bank
LAS	League of Arab States
LDC	Least Developed Country
LED	Light Emitting Diode
LPG	Liquefied Petroleum Gas
MDB	Multilateral Development Bank
MDF	Multilateral Development Fund
MDG	Millennium Development Goal
MENA	Middle East and North Africa
NEEREA	National Energy Efficiency and Renewable Energy Action (Lebanon)
NGO	Non-Governmental Organization
ODA	Official Development Assistance
OFID	OPEC Fund for International Development
ONE	Office National d'Electricite (National Moroccan electric utility)
PERG	Programme d'Electrification Rural Global
PPP	Public-Private-Partnership
PV	Photovoltaic
RE	Renewable Energy
SCF	Strategic Climate Fund
SDC	Swiss Agency for Development Cooperation
SIDA	Swedish International and Development Cooperation Agency
SME	Small to Medium Enterprise
SODIS	Solar Disinfection (Solar Ultraviolet Water Disinfection)
SWH	Solar Water Heater
UAE	United Arab Emirates
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
USD	United States Dollar
USTDA	United States Trade and Development Agency
VCU	Voluntary Carbon Units
VER	Voluntary Emissions Reductions
WHO	World Health Organization

EXECUTIVE SUMMARY

About 1.3 billion people still live without electricity globally forming about 18.5% of the earth population[1]. In the Arab world, the least developed countries suffer from very low electrification rate specially in the rural areas. On the other hand, countries in conflict areas suffer from long hours of outages related to the crisis. The lack of energy services usually aggravates the cycle of extreme poverty in the majority of rural areas, resulting in poor socio-economic conditions, which in turn negatively affect basic needs such as food security, water supply, health care, social services, education, communication and overall development.

Access to modern energy addresses the above problems and enhances economic growth and social development in remote rural areas. On the household level, access to modern energy provides more time for women to care for children and enhances women productivity, while children would have extra time for education and learning activities. It improves health, reduces energy related accidents and fires, reduces school absenteeism for children, work interruption for men and increases money generating activities. At the community level, it would enhance water access, reduce waste, improve the environment, while helping in diversifying local business activities leading to the reduction of extreme poverty in rural areas.

All ESCWA Member Countries pay great attention to setting up energy strategies which depend on the diversification of fuel sources, the application of energy efficiency improvement measures, and expand the use of renewable energy resources. As most of the Arab countries have set renewable energy targets, large projects opportunities are foreseen in the coming decade. However, with the exception of Djibouti, no country in the Arab world had set a specific target for rural renewable energy. Moreover, data and statistics related to direct renewable energy applications and motive power in rural areas does not exist and very little focus have been made to such information. This makes it harder for investors to assess business opportunities for energy access and sustainable development in rural areas.

When dealing with energy access, electricity is given usually the first attention. This is due to the fact that electric energy is flexible in providing different services and applications. Electrification of rural areas can be based on national grid expansion, local mini-grids and off-grid solutions. Mini and off-grid electricity generation solutions could be based on diesel generators which is subject to the availability, affordability and fluctuation of fuel prices. Renewable sources for energy generation include PV, wind, biofuels, biogas and mini hydro solutions. In many cases, renewable energy sources represent the only solution to secure the supply of modern energy services to rural areas far from the grid. In general, the adoption of a specific solution and technology depends on proximity to the national grid, local conditions, infrastructures and geographical characteristics of rural areas.

While electricity provides flexibility, other forms of energy are important in direct rural applications including cleaner fuels and mechanical power. These forms of energy have been given less attention in energy policies, although they can provide direct benefits to local communities and rural households. These include modern fuels for cooking and heating; solar energy at low temperature applications for cooking, heating, water heating, water purification and agro-business; wind and solar energy for water pumping, motive power and agro-businesses and processes. In that

[1] IEA World Energy Outlook, 2012

respect, more emphasis should be made on gathering adequate data, information and statistics on the different application and motive power that can benefit directly from renewable sources.

There are a number of mechanisms, funds and organizations available to finance renewable energy and energy efficiency projects in general. These mechanisms, funds and organizations include within their mandates a rural development component. In order to make the most out of these, strategic long-term vision for rural development including modern energy access should be set by the central governments. A holistic approach should be adopted when developing such strategies as well as policies, regulations, incentives and support mechanisms. Adequate consideration should be made to enhance appropriate renewable energy applications in rural areas. Enabling conditions include also awareness, capacity building, financial and industrial capabilities as well as business and market know-how. Local benefits should be addressed including local business development, training and technology adapted for local conditions. The holistic approach should answer to the different challenges at the different levels from government to local authorities, institutional frameworks, education and technical expertise, subsidies, capital investment and household affordability.

I. INTRODUCTION

A. BACKGROUND

In many developing countries, a large percentage of the population lives in isolated rural communities, where they depend mainly on biomass in the form of firewood and charcoal to meet their energy needs. Lack of energy services has exacerbated the cycle of extreme poverty in these rural areas, resulting in poor social and economic conditions and has had an adverse impact on basic issues such as food security, water supply, health care, education, communication, and overall development. Accordingly, comes into view the importance of introducing affordable energy access in remote rural areas to help alleviate poverty, enhance productivity along with improved social and economic conditions.

Promoting the use of renewable sources of energy in ESCWA countries, not only addresses the issues of energy access and energy security by providing energy to remote areas which do not have access to conventional and imported energy sources, but is also environmentally friendly due to its associated reduced emissions.

In that respect, ESCWA has launched a project focusing on promoting renewable sources of energy in ESCWA member countries in rural areas.

B. ENERGY ACCESS DEFINITION

The basic definition of energy access is the ability to reach energy sources to fulfill basic needs including lighting, cooking and heating as well as performing basic jobs that require motive power such as water pumping, milling, grinding, and non-motive power such as refrigeration, communication, crops drying and other agricultural works. Energy is thus needed not for itself but for the services it can provide. To fulfill the basic services needed, rural population in Least Developed Countries rely on wood and charcoal for cooking and heating, and on human and animal resources for motive power which lead to lower productivity that hinders development and poverty reduction.

Thus comes the definition of access to modern energy services: the ability to reach electric power and other modern energy carriers such as natural gas, liquefied petroleum gas (LPG), biogas and ethanol. It also encompass acquiring improved devices and appliances such as lighting equipment, cook stoves, water pumps, milling, grinding, agriculture processing and transportation means. Thus, access to modern energy in rural areas is not only accessing the national power grid, but also fulfilling basic needs and performing basic jobs using different resources including off-grid electric solutions, renewable and fuel based resources.

On the other hand, cost of modern energy needs to be affordable to rural population. The term "Affordability" encompass a) initial investment costs, b) ability to cover these costs, c) technology selection suitable for the local geographical characteristics as well as the local socio-economic conditions, d) costs and complexity of the operations and maintenance of the equipment, and e) availability of local know-how for the continuity and sustainability of the operations and maintenance of the equipment or accessibility to imported know-how. In that regard, access to affordable modern energy should take into consideration all the above leading to enhanced sustainability, availability, reliability and quality of services, especially in poorer rural areas. For

that purpose, in addition to innovative financing mechanism needed to cover the initial investment costs required to boost energy access in poorer areas, local training and know-how transfer is equally crucial for the sustainability of the services.

II. CURRENT SITUATION IN THE ARAB WORLD

As per IEA data[2], about 1.3 billion people still live without electricity globally forming about 18.5% of the earth population. Most of these live in rural areas. As electricity is seen as the main form of modern energy that can be used in different applications, table 1 below shows the percentage of the population with access to electricity in the Arab World.

Table 1: Access to electricity in the Arab World in 2010

Region	Population without electricity millions	Electrification rate %	Urban electrification rate %	Rural electrification rate %
ESCWA Countries				
Bahrain	*0.0*	*99.4*	*100*	*94.7*
Egypt	*0.3*	*99.6*	*100*	*99.3*
Iraq	*0.6*	*98.0*	*100*	*94.1*
Jordan	*0.0*	*99.4*	*99.6*	*98.7*
Kuwait	*0.0*	*100*	*100*	*100*
Lebanon	*0.0*	*99.9*	*100*	*99.2*
Libya	*0.0*	*99.8*	*100*	*99.1*
Morocco	*0.4*	*98.9*	*100*	*97.4*
Palestine[(a)](2006)		*99.7*	*99.8*	*99.4*
Oman	*0.1*	*98.0*	*99.9*	*92.9*
Qatar	*0.0*	*98.7*	*100*	*68.8*
Saudi Arabia	*0.3*	*99.0*	*100*	*94.4*
Sudan	*28*	*35.9*	*47.5*	*28.1*
Syria	*1.6*	*92.7*	*100*	*83.5*
Tunisia	*0.1*	*99.5*	*100*	*98.5*
United Arab Emirates	*0.0*	*100*	*100*	*100*
Yemen	*15*	*39.6*	*75.0*	*23.1*
Other Arab Countries				
Algeria	*0.2*	*99.3*	*100*	*97.9*
Comoros[(a)](2004)		*40.1*		
Djibouti[(a)](2004)		*49.7*	*56.9*	*10.2*
Mauritania[(a)](2005)		*30.1*	*47*	*2*
Somalia		*No Data*		
World	1,267	81.5	94.7	68.0

Source: IEA World Energy Outlook 2012,
(a) UNDP & WHO 2009[3]

[2] IEA World Energy Outlook, 2012
[3] UNDP, WHO, The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa, 2009

The ESCWA Member Countries can be divided into three groups in terms of national wealth and energy access:

i) The Gulf Cooperation Council Countries (GCC Countries: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates) with little to no energy access problems but are becoming increasingly interested in renewable energies.

ii) The Least Developed Countries (Sudan and Yemen), and countries in conflict areas (Palestine and Syria) where energy access and energy security are crucial, especially in remote areas. The table shows clearly the energy access problem in Yemen and Sudan with rural electrification rates 23.1% and 28.1% respectively. As for Palestine and Syria, energy access and energy security depends on the political and conflicts situation on the ground.

iii) The other ESCWA Member Countries (Egypt, Iraq, Jordan, Lebanon, Libya, Morocco and Tunisia) enjoy high level of awareness and potentials, but would require stronger technical knowledge transfer as well as efficient financial mechanisms to boost investments in renewable energies specially in remote areas.

With the exception of Algeria, the rest of the Arab World, (Comoros Islands, Djibouti, Mauritania and Somalia) shares the same characteristics of Sub-Saharan Africa with low levels of national electrification affecting mainly poor rural areas. In these countries households are heavily dependent on wood fuels for basic needs such as cooking and heating.

On the other hand, as the data provided is that of 2010, special attention should be made to the effect of the political and security instabilities that the region passed through since 2011 specially in Syria where the infrastructure has been heavily damaged during the on-going conflict and with more than 2 million refugees[4] registered by the UNHCR scattered within Syria and the neighboring countries with rare access to basic needs.

[4] UNHCR website: http://data.unhcr.org/syrianrefugees/set_language.php?Code=AR

III. PROJECTS OPPORTUNITIES IN DEPLOYING RENEWABLE ENERGY APPLICATIONS IN RURAL AREAS

In developing rural markets, active players at the public, private and banking sectors face challenges of lack of information, statistics and technical skills related to renewable energy applications, as well as challenges related to the smaller market size. Moreover, clear market framework for renewable energy services in rural areas need to mature, especially when local population cannot afford paying the capital costs required to install the equipment. On the other hand, financing options suitable for low income rural population should be well analyzed to insure sustainability of the market and therefore wider deployment of renewable energy.

In addition to the installation of renewable energy systems, related local business opportunities evolve as the market develops. These include technical training, troubleshooting and support, maintenance, spare parts and logistics. A complete economy would thus evolve around the new technologies introduced in rural areas helping thus in generating job opportunities, reducing poverty and reducing rural migration.

Project opportunities in deploying renewable energy applications vary from country to country depending on several factors including policies, level of access to modern energy, affordability, economic and social situation, public awareness and know-how, financing options and subsidies, and finally applications and benefits of deploying renewable energy. But in general, project opportunities for renewable energy are huge in the Arab region countries in the coming two decades as most of the Arab countries have set ambitious targets for the share of renewable energy in their energy mix (Table 2). However, at the rural level, more efforts have to be made to build up the market, especially in the Least Developed Countries. Note that only Djibouti has specified a specific target for rural energy.

Table 2: Renewable Energy Share Targets for the Arab Region

Country	Total Renewable Energy Target
ESCWA Countries	
Bahrain	*5% by 2020*
Egypt	*20% of electricity generation by 2020, of which 12% is wind*
Iraq	*2% of electricity generation by 2016*
Jordan	*7% of primary energy by 2015; 10% by 2020*
Kuwait	*5% of electricity generation by 2020; 10% by 2030*
Lebanon	*12% of electrical and thermal energy by 2020*
Libya	*3% of electricity generation by 2015; 7% by 2020; 10% by 2025*
Morocco	*42% of installed power capacity by 2020*
Palestine	*25% of energy from renewables by 2020; 10% (or at least 240 GWh) of electricity generation by 2020*
Oman	*10% by 2020*
Qatar	*At least 2% of electricity generation from solar by 2020*
Saudi Arabia	*20% electricity generation by 2032*
Sudan	*No Data*
Syria	*No Data*

Country	Total Renewable Energy Target
Tunisia	*11% of electricity generation by 2016, 25% by 2030; 16% of installed power capacity by 2016, 40% by 2030*
United Arab Emirates	*Dubai: 5% of electricity by 2030, Abu Dhabi: 7% of electricity generation capacity by 2020*
Yemen	*15% of electricity by 2025*
Other Arab Countries	
Algeria	*6% of electricity generation by 2015; 15% by 2020; 40% by 2030, of which 37% is solar (PV and CSP) and 3% is wind*
Comoros	*No Data*
Djibouti	*30% of rural electrification from solar PV by 2017* *100% renewable energy by 2020*
Mauritania	*15% of primary energy (excluding biomass) by 2015; 20% by 2020*
Somalia	*No Data*

Source: REN21 Renewables Global Status Report[5]

When analyzing project opportunities, the Arab region can be divided into three groups in terms of energy access, wealth and awareness:

i) GCC countries: These countries enjoy high level of modern energy access with reliable and affordable grid based electricity. Meeting the high growth in demand is a challenge for the governments with plans for new power plants currently considered. The introduction of nuclear energy for power generation in the GCC countries is meant to supply part of the demand increase. In this context, the GCC countries are more and more interested in renewable energy and energy efficiency initiatives. With a target of 20% electricity generation coming from renewable energy, Saudi Arabia is leading the GCC countries[6]. On the other hand, Masdar city in the UAE represent the business interest in such technologies.

   However, renewable energy and nuclear energy projects in the GCC countries tend to be larger ones supplying the national grid in a bid to diversify primary energy sources, reduce fuel consumption and help in reducing emissions from electricity generation. Renewable rural applications, similar to single dwelling applications, need extra efforts in building up the market specially in countries where electricity and fuel are heavily subsidized leading to minimal economical interest at the individual basis to install renewable energy applications, unless equal subsidies are provided by the governments to encourage the wide deployment of renewable energy in rural areas. On the other hand, deployment of renewable energy at the individual household level in GCC could be encouraged using culture stimulus by successfully installing systems at the dwellings of key figures in each community or village that might be replicated by other enthusiasts to form a market trend.

ii) The Least Developed Countries, including the Sub-Saharan Arab African countries: Facing low electrification rates, access to modern energy is crucial for the development of the poor rural areas. When adequate policy and financing support is provided combined with

[5] REN21 Renewables 2012 Global Status Report
[6] ibid.

technical and commercial know-how, projects opportunities in rural areas would be substantial for local economy and help develop Small and Medium Enterprises (SMEs) and generate job opportunities. However, the main problem is to be able to mobilize the different resources (political, financial, human, technical, commercial,...) in a concerted way to build up the market for small scale renewable energy applications suitable and affordable for the local economy and culture.

iii) The rest of the Arab world: having common characteristics of high rural electrification rates, but with higher interest in renewable energy. Net oil importing countries would like to reduce their energy bills through renewable energies, while net oil exporting countries would like to conserve their indigenous energy resources for the coming generation in a bid to sustain these resources as much as possible. Renewable energy targets are set in all these countries, but with no specific rural targets. National policies have been adopted in most of these countries to help boost renewable energy and energy efficiency market. However, subsidies on energy products and electricity in some of these countries distort market operations.

On the other hand, given the conflict situation in Syria where the war is taking its toll on the energy infrastructure, a market for current and fast solutions to cover basic needs is developing, including low efficiency diesel generators. When the conflict in Syria comes to an end, huge project opportunities in the energy field will be available and renewable energy in rural areas is no exception. Thus preparing for the reconstruction of Syria might involve committing to technical training and know-how transfer on renewable energies.

IV. ROLE OF ENERGY ACCESS IN ENHANCING SOCIO-ECONOMIC DEVELOPMENT OF RURAL AREAS.

A. Modern Energy Access Impact on Socio-Economic Development of Rural Areas

Solid fuels in the form of wood fuel, coal and/or charcoal in remote poorer rural areas are used for basic household needs such as cooking and heating. It typically requires hours each day for the collection and preparation of the solid fuel. This work time, often done by women and children, can be used in more productive activities if access to modern energy is available. Furthermore, burning solid fuels results in indoor pollution leading to health problems and is prone to domestic accidents causing death from suffocation and/or fire in some cases. On the other hand, using human and animal power for required motive activities such as grinding, milling and water pumping lacks high productivity and is time consuming.

Access to modern energy addresses the above problems and enhances economic growth and social development in remote rural areas. On the household level, access to modern energy releases women and children from the daily tasks of collecting and preparing solid fuel, providing women more time for more productive activities and better care for children raising. Similarly, children would have extra time for education and learning activities that would enhance their future perspectives breaking thus the cycle of extreme poverty.

Moreover, modern energy is cleaner and less polluting, reducing thus domestic health problems affecting all members of the household. This would reduce school absenteeism for children, decrease work interruptions for men, and increase availability of women for better child care and productive activities.

In addition to the basic household needs, when access to modern energy is directed towards money generating activities, such as refrigeration, heat and/or motive energy wanted in irrigation, agriculture and agro-processing, it would help diversifying business opportunities, enhancing productivity and thus reducing poverty and improving standards of living.

On the other hand, involving the local rural communities in the process of installing, operating and maintaining modern energy equipment would strengthen community based environmental responsibility, water supply, waste handling, health improvement, education and social activities. In particular, electricity enhances health through better refrigeration needed for vaccines and other medications, as well as it enhances education by providing lighting for studying after sunset and through providing the possibility of introducing advanced tools such as computers to the local schools.

Renewable energy has an added value to other modern energy sources. It is sustainable, locally available, clean, and, if financing is available for the initial capital cost, affordable to the poorer rural population in terms of operations and maintenance. Moreover, due to its simpler installation, operation and maintenance, local workers could be trained to perform these activities and thus building the capacity of local skilled technicians with direct impact on enhancing employment opportunities, diversifying further business and investment prospects in remote areas, and boosting installations in a multiplier effect if adequate strategies, policies, rules, regulations, financial and technical support mechanisms are put in place at the national government level.

Furthermore, while providing the services required, renewable energy in rural areas reduces the dependence on costly fossil fuel, mainly diesel and kerosene, not to mention fuel prices fluctuations, and saving thus such costs to higher standards of living. These benefits of renewable energy applied in rural areas lead to improved energy supply, being electrical or for direct applications, with economic stability and growth

In general, access to modern forms of energy is a necessary condition for rural socio-economic development. But to reach the development phase, energy should be used in productive and money generating activities to improve household earnings and alleviate poverty. Such activities include industrial production (agro-industry for rural areas), agriculture works (milling, grinding, seeding, trilling, spinning, squeezing, ...), transport enhancement to enhance mobility and exchange of goods and services, communication to build up business opportunities with regional and national entities and companies, health improvement, advanced and quality education. Such activities should be accompanied with adequate policies and strategies at the local, regional and national levels with the commitment of the private sector as the prime mover for business growth and thus socio-economic development.

B. Modern Energy Access and the MDGs

Taking the MDGs as indicator for socio-economic development, the link between energy access and MDGs can be summarized below:

MDG 1. Eradicate extreme poverty and hunger:
Access to modern fuels and cooking stoves can reduce time spent to gather solid biomass in the form of wood and charcoal, thus providing extra time to do more productive work for money generation in the poorer remote rural areas. Moreover, mechanical energy such as wind pumps increases crops production and enhance agriculture productivity through adequate irrigation and advanced mechanical assistance. Reverting to fuel based mechanical options would thus be only for backup and assistance at the community or industry level. On the other hand, losses incurred post-harvest due to inadequate preservation techniques and/or unavailability of chilling rooms would be reduced by improved techniques such as drying and/or chilling. Finally, energy access and support in remote rural areas is achieved usually through local SMEs, thus opening new business opportunities and generating new jobs at the local level.

MDG 2. Achieve universal primary education:
Access to modern energy would free children from the burden of helping in gathering and preparing solid biomass. It also reduces in-house pollution improving thus the health of young pupils and reducing thus absenteeism. On the other hand, access to modern lighting systems improves study conditions providing longer hours to study at night specially during winter when daylight is affected by clouds with shorter days. Moreover, cleaner energy and advanced heating/cooling devices reduces school costs and provide healthier study environment.

MDG 3. Women's empowerment:
Access to cleaner energy reduces time spent by women and young girl gathering solid biomass and water for cooking and drinking. It also reduces cooking time which would be used in productive activities, education and better child care. It would also enhance household environment reducing thus health problems specially for women bound to their homes. On the other hand, modern energy access reduces the distance travelled by women to fetch wood fuel and water which reduces the risks of assault specially in conflict areas.

MDG 4. Reduce child mortality:

Using modern energy reduces indoor pollution that have direct effect on child health. It would also reduces pregnancy and embryo problems related to indoor pollution that increase miscarriage, pre-delivery and child health problems. Moreover, better child care using refrigeration for pediatric medication and vaccines on a community level helps protecting children. Clean water access could also be enhanced through water purification, water boiling and/or water pumping from clean wells underground reducing thus water related diseases. On the other hand, using candles or kerosene for lighting and wood fuel for cooking might lead to accidents and child burns which can be avoided using PV based lighting and improved cook stoves.

MDG 5. Improve maternal health:

Modern energy reduces the time spent near the fire for cooking and heating purposes as well as reducing fire related pollution and particles inhale. Reduced indoor pollution reduces health and respiratory problems for pregnant women. Moreover, modern energy access reduces the burdens on pregnant women and new mothers to gather wood fuel and water resulting in reduced risks of health problems related to lifting heavy loads. On the other hand, modern energy enhances the possibility to have closer medical facilities with modern equipment and laboratory for safer delivery and caesarean operations if needed. It will help medical personnel settle in remote areas caring for the rural population.

MDG 6. Combat HIV/AIDS, malaria, and other major diseases:

Lower indoor pollution helps reducing health problem risks in general. With modern energy access, medical facilities could be closer to rural areas with adequate equipment and laboratories where vaccination and drugs can be stored in refrigerators, improving thus the availability of treatment when needed and where needed. Moreover, sterilization of equipment as well as distribution of medication would enhance rapid response to health alerts in remote villages, enabling health and medical workers to react faster and giving them the minimal infrastructure to settle in these areas. Finally, sterilizing water for drinking using modern energy helps preventing health problems and combating major diseases.

MDG 7. Ensure environmental sustainability:

Modern energy access reduces reliance on wood biomass, and thus reduces deforestation specially in areas where wood plantation is scare. It also reduces greenhouse gasses emissions through more efficient and cleaner energy carriers and cook stoves. On the other hand, modern energy improves irrigation activities and agriculture productivity helping in reducing climate change impacts on the poorer rural population.

MDG 8. Develop a global partnership for development

Global partnership is crucial for capacity building, know-how transfer and development of optimal solutions to improve access to modern energy in remote rural areas. Market development, prices reduction, trade and exchange of material, products and equipment is a global task that should benefit from the advanced research and development in developing and wealthy economies, and from practical experiences that took place in different countries around the world. Lesson learned, best practices and pitfalls should be shared as well as development policies, financial mechanisms, programmes, projects and logistic needs. Each country and each region has its specificities such that a successful programme in one area might not be that successful in another but sharing knowledge and experience would enlighten stakeholders in a specific region to develop their own successful programme.

V. RURAL AREAS ELECTRIFICATION

When dealing with energy access, electricity is given usually the first attention. This is due to the fact that electric energy is flexible in providing different services from lighting, heating and cooling, to motor and other forms of services and applications. Moreover, access to electricity helps boosting productivity and reduces time required to perform basic jobs.

Electrification of rural areas can be based on national grid expansion, local mini-grids and off-grid solutions.

A. GRID EXPANSION

Electrification across the world has been made through national grid expansion fed by large centralized power plants with extensive transmission and distribution networks. Grid expansion provides the advantages of centralized planning, operations, control and management with larger power plants leading to more efficient and reliable supply at a lower cost when compared to distributed fuel based electricity generation. Moreover, power plant sites are chosen as much as possible close to demand centers in urban areas taking into consideration optimal network operations.

However, when it comes to remote rural electrification, investment requirements in transmission and distribution networks become higher due to larger areas to be covered and in some cases tougher topography where networks have to be expanded. Moreover, when dealing with larger distances, higher technical losses will be incurred and extra costs would be needed to insure the quality of the service in terms of reliability and voltage drop. Higher network expansion costs are also accompanied with low demand due to lower population density and lower consumption per capita in rural areas. These problems lead to higher financial burdens that utilities might not be able to sustain at local tariffs without some sort of a subsidy specially that poor rural population in general cannot afford higher tariffs even for basic household services such as lighting, refrigerating and heating.

B. MINI-GRIDS AND DISTRIBUTED GENERATION

Mini-grids are isolated local electric distribution networks fed by smaller distributed generation sets to cater for local demand. Such grids are usually erected, maintained and operated by local authorities like municipalities, cooperatives and communities. Mini-grids would alleviate the costs needed for long transmission and distribution lines to reach remote areas and allow faster electrification of these areas. These activities would help introducing new jobs at the local market in addition to providing electricity expected to have direct effect on the local economy.

1. Diesel Based Distributed Generation

Diesel based generation sets are usually more expensive and less efficient than larger centralized power plants on an energy unit basis. However, they would help overcome the constraints facing the expansion of the national grid to remote areas. On the other hand, as mini-grid solutions are based on local needs, operating schedules could be planned to address these needs and thus help in

reducing diesel and operations costs while providing the services required locally. Nevertheless, diesel based generation in remote areas faces the challenge of securing needed fuel specially in areas with inadequate road and transport infrastructure and in areas with conflicts or security problems. In areas where access to diesel is affordable, such generators might be seen as the most attractive solution due to their lower upfront capital costs, market availability, technical assistance know-how, reliability and security of supply. However, with technology advancement and decrease in required capital costs, some renewable energy sources are becoming less expensive when detailed long term financial analysis are conducted.

2. Renewable Sources Distributed Generation

Given the fuel sourcing challenges and the fluctuation in fuel prices, renewable energy sources are becoming more attractive for rural electrification. Such sources are locally available ensuring security of supply and releasing local communities from the burden of acquiring and transporting fuel as well as from adapting to the fluctuating fuel prices. Moreover, renewable sources are cleaner and would enhance local economies through diversification of money generating jobs and boosting productivity.

Renewable energy sources for mini-grid include hydro, solar, wind and biofuels energy. As technology improves, renewable energy conversion techniques becomes easier to install and less expensive, but still depends on the technology used, infrastructure available and market size. On the other hand, due to the intermittent nature of renewable energy, a combination of different technologies might be needed to secure continuity of supply. Moreover, the up-front capital costs of renewable energy might be the main barrier to their implementation which necessitate the adoption of suitable financing mechanisms supported by local/central governments.

(a) Hydro mini and micro generation

Hydro resources are the most mature, stable and controllable technologies that can be adapted to smaller scale generation and larger scale. In rural areas where hydro resources are available, micro and mini-hydro power plants could be the least expensive solution to provide electricity on a local basis. Mini and micro hydro generation are often run of the river not requiring the construction of large dams but lack the larger water storage capacity to secure continuity and reliability of supply during the low rain seasons. On the other hand, mini-hydro generation offers an added value to sustainable development in rural areas as it would enhance water supply and irrigation.

In that respect, Sudan has large water resources that could be utilized efficiently especially in the equatorial region where rainfalls are larger. Moreover, the water flow in the Nile river could be used to develop in-stream power generation turbines.

(b) Solar PV systems

The Arab region has an advantage of being in the solar ring with high levels of radiations throughout most of the year. PV systems are formed of PV panels, charging controls, batteries, LED lights for lighting, and inverters if AC current is needed to operate small appliances like cell phones chargers, radio and TV. PV systems are easy to install, maintain and operate. Moreover, its DC current output can be used directly in lighting without the need for inverters. For motor energy, larger systems with AC inverters would be needed. Due to its modularity, PV systems in remote

areas are more suitable as home based electricity source rather than mini-grids but still its potentials should not be overlooked when developing mini-grid systems specially when community based services are needed like main square and market lighting, local basic infirmary needs, water pumping and agro-business applications.

(c) Solar CSP systems

Solar electricity generation systems based on solar thermal energy (e.g. Concentrated Solar Power, CSP) requires more advanced knowledge for the installation, operation and maintenance of the system since it includes mechanical and rotating components to collect solar energy and generate electricity. CSP systems are mainly composed of solar energy reflectors (mirrors), energy collectors being at the focal point of the mirrors where solar energy is concentrated, and an electric generation unit. Water is also needed as the coolant agent for the generator. Due to its complexity and water requirements, CSP systems might not be the optimum solution for remote areas as it requires extensive training of the local population to operate and maintain the system. It also requires extensive installation training that would hinder the vast deployment of CSP systems in remote areas.

(d) Wind

Wind energy is a promising source of energy in remote rural areas for mini-grids given the size of energy it can provide. However, wind energy is highly intermittent and accurate wind forecasts require advanced technologies not affordable for rural population. Special attention is thus required for the design of the energy storage capacity to ensure continuity and reliability of services in isolated mini-grids. Wind energy could also be combined with other electricity generation means, like diesel generation to ensure continuity of supply. However, such combined solutions would add up to the initial capital costs required.

(e) Biomass

Biomass use for electricity generation in mini-grid application could be produced in the form of 1) bioethanol through the hydrolysis and fermentation of crops and crops residues rich in sugar and starch content, 2) biodiesel through the process of extraction, esterification[7] and hydrogenation of oil crops and animal grease, and 3) biomethane through the process of anaerobic digestion of animal residues and organic material waste. Biofuels could be mixed with diesel or lighter fuels in conventional generation sets to reduce reliance on expensive fuels.

At a larger scale, cogeneration in industries has been used to produce process heat and electricity. In particular, sugarcane waste from sugar industries as well as paper and wood waste are used in boilers to produce steam for industrial processes and electricity generation.

C. OFF-GRID SOLUTIONS

Mini-grids in rural areas would require know-how and collective mobilization of remote communities. It also requires mobilizing capital investment to cover for the up-front costs of

[7] Esterification is a chemical reaction that results in the formation of an ester and water, catalized by a strong inorganic acid and heat. The ester produced from plant and animal grease is a biofuel containing energy from carbon fixation.

planning, design and construction. Poorer communities might not be able to afford these costs and thus off grid, stand-alone solutions might present better options. Introduction of effective stand-alone off-grid solutions would be replicated on a wider level as awareness, capacity building and local technical training increases, provided that adequate financial and institutional instruments are put in place.

1. Off-Grid Diesel/Gasoline Generators

Off-grid solutions can be based on costly diesel/gasoline generation sets due to the reasons mentioned above mainly: lower capital costs, market availability, ease of installation and technical know-how provided that access to diesel/gasoline is affordable. However, on the longer term, renewable energy becomes competitive specially in countries where fuel costs are not subsidized or in remote areas where access to fuel is restricted by long distances and/or inadequate or unsafe transport routes and infrastructure making local fuel prices even higher.

2. Off-Grid Renewable Sources for Electricity Generation

(a) PV lantern

The basic off-grid system is the PV lantern where the PV cell, battery and LED light are integrated in a single lantern. PV lantern is effective for lighting purposes in remote rural areas as well as in urban areas where frequent outages occur due to lack of generation capacity (e.g. Lebanon) or security problems (e.g. Syria) and where other sources for lighting are not affordable or not available.

(b) PV house systems

PV house systems, provide the household with the basic electricity needs, allowing for effective lighting, entertainment (radio, TV), communication (cell charging) and other basic needs. Due to its modularity, and if affordable by the household, PV systems could be expanded to cover for refrigeration and other motor applications.

(c) Wind and hydro energy

Where available, wind energy, mini and micro hydro electricity generation provide enough electricity for larger loads including mechanical loads such as milling and agro-processing. However, for mechanical power, direct applications of wind and hydro energy would be more efficient depending on the application and the proximity to the sources from the load, specially if the hydro generator is based on the run of the river sources with not enough water storage to secure continuity of services.

(d) Biomass

Finally, biomass in the form of biogas can be used to run small electric generators. Biogas is produced through anaerobic digestion of animal and organic waste. Experience from India and China proves that biogas produced from digesters at the household level could be a source of energy for electricity generation, but is more efficient and widely used in direct applications for cooking and heating. The main challenge for digesters in the Arab World is the availability of

enough animal waste collected at the digester level to produce the required volume of gas. This is especially true if the cattle are not kept in a single place, but rather pastured in open fields.

D. Solution Selection

In general, the adoption of grid expansion, mini-grids and/or off-grid solutions depends on the local conditions of rural areas. Grid expansion would be seen preferable when the distance from the rural area in question to the nearest grid point is relatively short to allow for economic viability of the expansion. However, other technical factors should be taken into consideration such as the capacity availability of the distribution and transmission networks and the impact on the complete system operations. Moreover, availability of generation capacity should be taken into consideration. Therefore, when adding the costs of grid expansion, distribution and transmission network reinforcement and generation capacity additions, local mini-grids or off-grid solutions might be more adequate, not to mention the different socio-economic impacts of the different solutions where distributed generation and off-grid solutions based on renewable energy would provide more job opportunities locally due to the installation works, operations and maintenance requirements needed.

On the other hand, the selection of the technology to be used in mini-grids and off-grid solutions depends also on the local infrastructures and geographical characteristics. Harder to reach remote areas with no adequate road and transport infrastructures would benefit more from local resources such as building small biomass digesters, or from smaller portable systems such as PV lanterns or PV based modular off-grid house systems. larger solutions for mini-grids would require better transport means as well as community based coordination to share the costs, workloads and benefits of energy accessibility. Hydro-energy would be seen the prime options in locations where water streams are available in sufficient flows most of the year like in Sudan and Morocco.

VI. ENERGY TECHNOLOGIES IN DIRECT APPLICATIONS FOR RURAL AREAS

While electricity provides a form of energy that is flexible for use in different applications, other forms of energy are important in rural applications including cleaner fuels and mechanical power. These forms of energy have been given less attention in energy policies, although they can provide direct benefits to local communities and rural households.

A. ACCESS TO MODERN FUELS

Modern fuels are defined in here as liquid or gaseous energy carriers with high energy contents that can be used for cooking and heating. Such carriers include natural gas, Liquefied Petroleum Gas (LPG), kerosene, biogas, and bioethanol. At the household level, cleaner modern fuel leads to improved, more efficient cooking and heating. Access to modern fuel releases poor rural populations from the hard work of gathering and preparing biomass fuel in the form of wood, coal, dung and/or charcoal. While access to natural gas, LPG and kerosene requires the existence of usable roads and transport infrastructure, biogas and bioethanol can be produced locally from animal and agricultural wastes and residues.

Table 3 shows the percentage of population with access to different type of fuels in the Arab World. In general, access to cleaner fuel in the Arab world is universal with the exception of Djibouti and Yemen where the use of modern fuels is not universal (86.1% and 62.9% respectively); and the exception of Mauritania, Comoros, Sudan and Somalia with only 37.3%, 24.5%, 6.9% and 0.3% of the population having access to modern fuels respectively. Building up cleaner fuel markets at affordable prices to poor rural population in these countries, given transport and roads infrastructure, might not be financially viable. However, developing capacity building programs and pilot projects to deploy digesters and fermentation techniques to produce biogas and bioethanol locally would be economically viable provided that enough agriculture and animal wastes and resources are available.

Table 3: Fuel used for cooking in the Arab World

	% of national population								
	Fuels used for cooking								Access to modern fuels
Country	Electricity	Gas	Kerosene	Charcoal	Wood	Dung	Coal	Other	
ESCWA Countries									
*Bahrain**									*>95*
Egypt	*0.2*	*96*	*3.4*	*0*	*0.2*	*0.1*	*0*	*0.1*	*99.6*
Iraq	*0.2*	*86.3*	*8.9*		*3.8*	*0.7*	*0.1*	*0*	*95.4*
Jordan	*0.2*	*99.5*	*0.1*	*0.1*				*0.1*	*99.8*
*Kuwait**									*>95*
Lebanon	*1.2*	*99.6*	*0.1*	*1.3*		*0*	*0*	*0*	*>99.6*
*Libya**									*>95*
Morocco	*0.1*	*91.1*	*0*	*0.4*	*7.8*		*0.2*	*0.4*	*91.2*

Country	% of national population								
	Fuels used for cooking								Access to modern fuels
	Electricity	Gas	Kerosene	Charcoal	Wood	Dung	Coal	Other	
Palestine	*0.5*	*99*			*0.5*			*0*	*99.5*
*Oman**									*>95*
Qatar				*0*	*0*	*0*	*0*		*100*
*Saudi Arabia**									*>95*
Sudan	*0.1*	*6.4*	*0.4*	*1.3*	*56.2*	*0.5*	*14.3*	*20.8*	*6.9*
Syria	*1.4*	*98.1*						*0.5*	*99.5*
Tunisia		*98.4*		*0.4*				*1.2*	*98.4*
United Arab Emirates	*4.8*	*94.4*						*0.8*	*99.2*
Yemen	*0.6*	*58.9*	*3.4*	*36.2*				*0.9*	*62.9*
Other Arab Countries									
Algeria	*0.5*	*98.2*		*0.3*	*0.9*			*0.1*	*98.7*
Comoros	*0.1*	*2.3*	*22.1*	*7*	*74.6*			*0.2*	*24.5*
Djibouti	*0.6*	*4.9*	*80.6*	*8.7*	*3.7*			*1.5*	*86.1*
Mauritania	*1.3*	*36*		*23.2*	*38.9*			*0.6*	*37.3*
Somalia	*0.1*	*0*	*0.2*	*33.1*	*66.5*			*0.1*	*0.3*

* Countries with a Gross National Income (GNI) per capita above US$ 10,500 and for which no survey data is available are assumed to have made a complete transition to using non-solid fuels as the primary source of domestic energy for cooking and heating

Source: UNDP & WHO 2009[8]

B. Solar Energy at Low Temperature

1. Thermal Solar Energy

Low temperature solar energy is an effective form of energy for water heating, space heating, cooking and drying. Solar Water Heaters (SWH) have short pay-back periods, low initial costs, and are easy to install. Successful programs for mass deployment of SWH has been seen in ESCWA countries like the PROSOL program in Tunisia and the PROMASOL program in Morocco. SWH markets in Egypt, Jordan, Lebanon, Palestine and Syria have increased dramatically in recent years, with Palestine leading the Arab world in total area of SWH. In addition to heating water, SWH are used for space and pool heating, replacing thus any other energy form needed for these applications.

2. Direct Solar Energy Applications

Low temperature solar energy can be used for cooking, drying and pasteurizing agricultural products. Using solar energy would replace burning high cost fuels or hard to get wood and solid

[8] UNDP, WHO, The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa, 2009

biomass in remote rural areas. Local capacity building and training is required for vast deployment of these technologies in rural areas.

Finally, solar water disinfection can be done using PV generated electricity, solar thermal heat or solar ultraviolet disinfection (known as SODIS):

- PV generated electricity disinfect water by producing electrolytic processes that damage the chemical structure of biological pathogens.
- Solar thermal energy heats the water to about 100^{o}C killing thus pathogenic biological agents.
- SODIS is a method where water in plastic or glass bottles is exposed to sunlight for 6 hours. The ultraviolet rays would affect biological pathogens disinfecting thus the water.[9]

Note that solar disinfection react on biological agents and may not react on toxic chemicals in water and thus might not result in safe drinking water in places where chemical pollution exists. Table 4 below depicts the disinfection results of the most common germs using SODIS.

Table 4: Research results of using SODIS on most common germs.

	Disease	Reduction with SODIS method (6h, 40°C)
Bacteria		
Escherichia coli	*Indicator for water quality & enteritis*	*99.999%*
Vibrio cholera	*Cholera*	*99.999%*
Salmonella species	*Typhus*	*99.999%*
Shigellaflexneri	*Dysentery*	*99.999%*
Campylobacter jejuni	*Dysentery*	*99.999%*
Yersinia enterocolitica	*Diarrhoea*	*99.999%*
Virus		
Rotavirus	*Diarrhoea, dysentery*	*90.0%*
Polio virus	*Polio*	*99.9 - 99.99%*
Hepatitis virus	*Hepatitis*	*Reports from users*
Parasites		
Giardia species	*Giardiasis*	*Cysts rendered inactive*
Cryptosporidium species	*Cryptosporidiasis*	*Cysts rendered inactive after > 10h exposure*
Amoeba species	*Amibiasis*	*Not rendered inactive. Water temperature must be above 50 °C for at least 1h to render inactive!*

Source: SODIS website[10]

[9] SODIS website: http://www.sodis.ch/methode/forschung/mikrobio/index_EN (accessed October 10, 2013).
[10] ibid.

C. Water Pumping and Mechanical Applications

Water supply is needed for drinking, irrigation, hygiene and animal watering. The availability of nearby water source would help reduce burdens on rural families to secure water needs. Wind and solar power can provide enough energy to pump water from deeper wells. With different sizes available on the market, water pumping can range from household capacity to community scale. As water can be stored in containers, intermittency of wind and solar energy is accepted in direct water pumping application provided that enough energy is available in a given time period to provide enough water. With improved irrigation using drip technologies, water requirement can be reduced while yields increase.

Other forms of energy that can be used to pump water include diesel pumps and river turbines that use the kinetic energy of water flowing in a river to pump water to the banks. Human power in the form of rope and bucket pulling, treadle pump (also based on human power) is also used in poorer areas.

Diesel pumps have the largest throughput of water when needed, but would require access to diesel oil for operation. When combined with a wind pump, the diesel generator will be seen as a backup system. In addition to their throughput and availability when needed, the advantages of diesel motors include the fact that with minimal adaptation works it can be used in different applications like milling, grinding and spinning needed in agro-processing affecting industrial and productive money generating activities. Using wind and hydro energy at the community level for such activities replaces fuel requirements to operate the diesel motor.

VII. PRE-REQUISITS AND FINANCING ENTITIES TO WIDELY IMPLEMENT RENEWABLE ENERGY PROJECTS IN RURAL AREAS.

A. Pre-Requisites for Enhancing Appropriate Renewable Energy Applications in Rural Areas

Enhancing appropriate renewable energy applications in rural areas requires a holistic approach when developing national strategies, policies, regulations, incentives and support mechanisms. Enabling conditions include also awareness, capacity building, financial and industrial capabilities as well as business and market know-how. In many instances, providing the financial mechanism alone would not be successful and funds reserved would just be allocated without being used. Likewise, providing enabling legal and regulatory environment alone might not mobilize the private sector to venture in deploying new innovations or in addressing new markets such as rural electrification. Risk factors as opposed to attractive returns should be balanced for investors to engage in new activities. Government role is thus instrumental in launching programmes that would attract investors to long term business. Programmes should be designed to mitigate risks while kicking-off market dynamics.

However, when a holistic approach is adopted, pre-requisites would be taken into consideration. First, strategic planning within the context of national energy planning is indispensible from developing rural and remote areas in terms of natural resources, potentials, expected growth of population, economic activities, required services, and so on.

Second, focus should be made on local then national benefits with local population benefits affecting positively the national level. Such approach makes energy access activities attractive to local population building up momentum and developing the market.

Third, emphasis should be made on building up local business know-how and market operations developing thus SMEs locally for long term commitment and take-over.

Fourth, local technical training for installation skills as well as operations and maintenance should accompany project implementation phases to secure sustainability and continuity of services.

Fifth, attention should be made to selecting, planning and designing most feasible technology to be adopted given local situation with a better understanding of the different options at hand. This should not exclude any technical option, including grid expansion, mini-grid, stand alone off-grid and direct applications solutions.

Sixth, developing local and national policies that should be integrated with other policies related to other fields and sectors such as environment, health, education, economy, transport, industry, food security, trade and market policies.

Seventh, rules and regulations should be developed to serve the integrated policies leading to coordinated framework that reduces legal and institutional risks and conflicts.

Eighth, incentives and support mechanisms shall be put in place to attract the private investors and entrepreneurs. Such incentives and support mechanisms should mitigate non-business related risks. Micro-finances and subsidies should be studied carefully to allow for market build up without distorting it. If not well designed, subsidies could lead to negative effects on the overall deployment

of modern energy in rural areas. Moreover, subsidies should be clear and transparent to avoid any misuse that would prevent it from reaching the intended beneficiaries.

Nineth, financing options shall be made available at all levels: end-user, local, regional and national. Financing is crucial to overcome the up-front capital costs required for the wide spread of renewable energy solutions.

In summary, pre-requisites for renewable energy applications deployment in rural areas shall take into consideration both the supply side and the demand side to match supply with demand and develop the market along with increased acquired experience at the supply side. Moreover, development in rural access to modern energy shall be accompanied by other activities that enhances socio-economic development leading to increased income generation and reduced poverty assuring thus development sustainability. Policies should avoid giving the private sector the exclusivity in developing renewable energy in rural areas as urban areas would be more attractive to investors given the higher market value and reduced risks.

Therefore, financing renewable energy projects in rural areas should take into consideration local constraints, culture, capabilities and socio-economic situation. Micro-financing mechanisms are more suitable for such projects given the micro size of individual project. A complete model for each area need to be put in place that takes into consideration human resources needed to follow up on the financing applications, disbursement and repayments.

The Moroccan Global Rural Electrification Programme (PERG) provides a good example of how the above pre-requisites were taken care off. Starting by a strategic vision and plan, and taking into consideration local developments, benefits and culture, policies and support mechanisms were put in place that resulted in quasi universal electrification up from only 18% rural electrification with improved economic condition in rural areas. On the financial mechanism side, PERG adopted the fee-for-services model to cover part of the financing requirements of rural electrification and to involve end-users in the process, making them more energy responsible. The rest of the financing requirements were covered by local authorities and by the national utility (ONE).

Box 1. The Moroccan Global Rural Electrification Programme (PERG)

PERG started in 1996 with a goal to achieve global electrification in Morocco by 2010. PERG targeted all households in all rural communities, integrated all available technologies that proved having economical viability given the local conditions, and fostered all available financial resources to support the initial installations as well as the operation and maintenance costs. Technical solutions adopted included grid expansion, mini-grids and stand-alone house systems based on renewable energy mainly solar PV. Financial resources were fostered from applying a 2% levy on grid electricity sales, local authorities' contributions and end-user payments. Fee-for-services market models were initiated to cover the large rural areas. The market evolved in rural areas leading to a dynamic business cycle. Fees paid by the entry level end-users were less than what they used to pay for candle lights and batteries. With more than US$2 billion budget over 15 years, rural electrification went from 18% in 1995, to more than 98.06% in 2012[11], boosting rural economies and enhancing rural standards of living.

[11] ONE Web site: http://www.one.org.ma/FR/pages/interne.asp?esp=2&id1=6&t1=1

On the other hand, innovative financial mechanisms need to be put in place to build on public-private partnerships boosting renewable energy and energy efficiency projects. In that respect, Lebanon has initiated the National Energy Efficiency and Renewable Energy Action (NEEREA). NEEREA is a financing mechanism that joins the private sector, banking sector and the public sector with the Lebanese Central Bank. Within 18 months, NEEREA had dispersed about US $100 million, which is a large figure given the size of Lebanon. The NEEREA had taken care of part of the above pre-requisites, while the private and banking sectors worked on the other part leading to the success of the programme.

Box 2. The Lebanese National Energy Efficiency and Renewable Energy Action (NEEREA)

The NEEREA is an initiative developed by the Ministry of Energy and Water, the Ministry of Finance and the Central Bank of Lebanon. Its main target is to involve the private and banking sectors in the energy efficiency and renewable energy markets in an effort to increase renewable sources and reduce electricity demand. It gives the commercial banks the ability to provide very low interest rate loans (near 0.6%) to the private sector and in return the required cash reserves the bank has to put at the Central Bank would be reduced. The selection of the project, technology used, size, terms of contracts were left to the private and banking sectors, but are overviewed and approved by the Central Bank and the technical arm of the Ministry of Energy and Water, namely the Lebanese Center for Energy Conservation (LCEC). NEEREA proved to be flexible, with the end-user having a single access point being his own commercial bank, while the process between the LCEC, the Central Bank and the commercial banks is simple. Of course, the technical document presented by the private sector should be based on sound engineering designs. The mechanism, after passing through an initial phase of slow start-up in 2012, had reached a total of about US $100 million of dispersed loans in 18 months. Even though the NEEREA was not intended solely for rural areas, several projects were initiated based on NEEREA in villages mainly due to, first, the pressure of long hours of rotating electricity outages, and second, the financial solution put in place to cover the initial costs of renewable energy and energy efficiency based solutions when compared to low efficiency diesel generators distributed all over Lebanon. Due to the success of NEEREA, the Central Bank of Lebanon is forecasting a total financing of US $150 million in 2014 and is seeking the support of international donors like the European Investment Bank (EIB).

In the Least Developed Countries where rural electrification rates are too low, end users cannot afford financing renewable energy and does not have the means to guarantee commercial financing through banks. Micro financing models become crucial to move forward in ensuring modern energy to rural areas. These models would rely on central government support and/or national, regional or international donors.

There are a number of mechanisms, trust funds and organizations available to finance renewable energy and energy efficiency projects in general. These mechanisms, funds and organizations include within their mandates a rural development component. In order to make the most out of these, strategic long-term vision for rural development including modern energy access should be set by the central governments. A holistic approach should be developed catering for rural needs and development. Government intervention is thus required to develop programmes based on the national strategy, benefiting from international funding and using available multilateral and bilateral financing mechanisms set by international stakeholders. The following sections list a number of

mechanisms, funds and organizations active in clean and rural development that can be addressed once a strategy and related programmes are developed nationally.

B. MULTILATERAL FUNDS

The Global Environment Fund (GEF) is an organization that assists in climate change mitigation, especially in developing countries. The GEF was established as the operating entity of the UNFCCC financial mechanism, and assists with promoting sustainable development and tackling environmental challenges. The funded projects support measures that minimize climate change by reducing the risk, or the adverse effects, of climate change. GEF partners with 10 agencies including: the UN Development Programme (UNDP); the UN Environment Programme (UNEP); the World Bank; the UN Food and Agriculture Organization (FAO); the UN Industrial Development Organization (UNIDO); the African Development Bank; the Asian Development Bank; the European Bank for Reconstruction and Development; the Inter-American Development Bank; and the International Fund for Agricultural Development.[12]

The Clean Technology Fund (CTF) is a part of the Climate Investment Funds (CIF) organized by the World Bank. The CIF also includes the Strategic Climate Fund (SCF). Although both are climate funds, the SCF supports technology piloting of new climate change mitigation approaches while the CTF is designed to facilitate developing countries in filling climate change funding gaps and adapting to climate change impacts[13].

The Global Climate Change Alliance (GCCA) was formed in 2007 and is managed by the European Commission (EC) to enhance support from the EU towards vulnerable developing countries. The GCCA provides both financial and technical assistance to address climate change and poverty as set out by the Millennium Development Goals (MDGs)[14].

The European Investment Bank (EIB) is the European Union's financing institution, of which all members of the union contribute capital to the bank. The EIB provides long-term finance and policy-driven support in economically weak regions. The institution works to implement external cooperation and development policies including private sector development, infrastructure development, energy supply security, and environmental sustainability[15].

The World Bank group is comprised of 187 member countries and is a family of five organizations that leverage loans, generally to poor and developing countries. Two of the bank's development institutions have financing activities relevant to climate change, the International Bank for Reconstruction and Development (IBRD) provides debt financing on the basis of sovereign guarantees and the International Development Association (IDA) provides concessional financing (interest-free loans or grants), usually with sovereign guarantees[16]

The International Finance Corporation (IFC) is also a relevant organization which provides various forms of financing without sovereign guarantees, primarily to the private sector. The IFC works towards stimulating private sector resources for development and implementation of solutions to

[12] Climate Funds Update. *GEF Trust Fund*. www.climatefundsupdate.org/listing/gef-trust-fund
[13] Clean Technology Fund (CTF) of the Climate Investment Funds (CIF). www.climateinvestmentfunds.org/cif/node/2
[14] Global Climate Change Alliance. www.gcca.eu
[15] European Investment Bank. www.eib.org
[16] The World Bank. www.worldbank.org

address climate change. IFC supports business models, technologies, and approaches that help mitigate and adapt to climate change.[17]

C. BILATERAL FUNDS

The Hatoyama Initiative was started by the government of Japan in December 2009 at the Copenhagen Summit replacing the previous Cool Earth Partnership (2008-2010). The Initiative is administered by the Japanese Ministry of Foreign Affairs and receives input from other public and private organizations, such as the Japan International Cooperation Agency (JICA). The Hatoyama Initiative works to provide assistance to developing countries that are already making efforts to reduce GHG emissions while also enabling economic growth and climate stability. The initiative works with partner governments in bilateral consultations to determine best means of support.[18]

The International Climate Initiative (ICI) is a German establishment that was founded in 2008 to target climate change and compliment Germany's development assistance activities. Activities are funded on a theme and regional level. Broadly, projects are sponsored that fall into the categories of assisting in adaptation to climate change impacts, promoting a climate-friendly economy, and promoting sustainable use of carbon reservoirs.[19] ICI's projects are mainly focused around energy efficiency and renewable energy.

The Official Development Assistance (ODA) of the Development Assistance Committee (DAC)[20] of the Organisation for Economic Co-operation and Development (OECD) aims at providing finance to the developing countries for the promotion of economic development and welfare. Financing should be concessional in character having a minimum of 25% grant element. The DAC has set an International Aid Target of donating 0.7% of GNP of each of its 28 member states. Dedicated independent governmental agencies has been set in some DAC countries to coordinate the ODA such as Japan International Cooperation Agency (JICA)[21] and Korea International Cooperation Agency (KOICA)[22].

D. DEVELOPMENT ORGANIZATIONS

Development assistance is typically used to promote economic development and welfare in developing countries, funding concessional or partial grant provided by donor and government agencies.

Several United Nations agencies and organizations have been active in promoting rural development and renewable energy deployment. UNEP[23], UNDP[24], UNIDO[25] and other organizations have been actively working in development, pilot, technical and financial assistance

[17] The International Finance Corporation. www.ifc.org
[18] Climate Funds Update. *Hatoyama Initiative.* www.climatefundsupdate.org/listing/hatoyama-Initiative
[19] International Climate Initiative. www.international-climate-initiative.com/en/about-the-iki/
[20] Development Assistance Committee. www.oecd.org/dac
[21] Japan International Cooperation Agency. www.jica.go.jp
[22] Korea International Cooperation Agency. www.koica.go.kr
[23] United Nations Environment Programme. www.unep.org
[24] United Nations Development Programme. www.undp.org
[25] United Nations Industrial Development Organization. www.unido.org

projects. UN secretariat, including the UN-ESCWA have been focusing on strategies, policies and capacity building activities at the governments level to enhance productivity and ensure sustainable development, while conducting some pilot demonstration projects. Coordination among various UN agencies lead to tangible results on the ground.

Europe Aid is responsible for implementing the European Commission's worldwide development projects. Europe Aid projects take into account EU strategies and long term programs for aid delivery. It aims to translate policies into practical actions and develop new ways of delivering aid such as budget support or sector-based funding. Europe Aid works closely with its partners to ensure proper implementation and realization of objectives.[26]

Europe Aid awards grants and contracts projects or activities that will aid development in a partner country. Contracts awarded by Europe Aid have specific targets or service provisions. Grants are direct financial contributions from the EU budget or from the European Development Fund and are awarded as donations to third parties engaged in external aid activities. The awarded grants are used to implement projects or activities that relate to the EU's external aid programs. Europe Aid grants fall into two categories:

- Grants for actions: this would be a direct contribution towards a project and aims to achieve a specific objective.
- Operating grants: this type of grant would finance operating expenditures of an EU organization that is working on behalf of a European development interest or policy.

United States Agency for International Development (USAID) finances climate support initiatives by providing funding to developing countries through multi-regional, regional, and bilateral programs. One of the main goals of this assistance is to help partner countries adapt to climate change and mitigate their emissions. USAID works with country governments and partners to develop shared priorities and implementation plans.[27]

The German Development Bank (KfW) works with local governments to implement capacity building through establishing effective financial systems and setting up governmental frameworks that promote development. Financial support includes expansion of infrastructure along with improving environmental protection, efficient use of water and energy, promoting environmentally friendly urban development and energy efficient traffic and transport systems. KfW helps partner countries invest in renewable energy sources by providing financial support and technical expertise.[28]

United States Trade and Development Agency (USTDA) provides grant funding to international project sponsors that supports infrastructure development and an open trading system. The development assistance USTDA provides focuses on building partnerships between U.S. companies and overseas project sponsors which in turn promotes private sector solutions to developmental challenges. The organization sponsors climate change projects. The USTDA provides program commitments through grants to overseas project sponsors for technical assistance, feasibility studies, and training.[29]

[26] Europe Aid. http://ec.europa.eu/europeaid/index_en.htm
[27] United States Agency for International Development. www.usaid.gov
[28] German Development Bank. www.kfw.de
[29] United States Trade and Development Agency. www.ustda.gov

E. POTENTIAL REGIONAL FUNDS FOR CO-FINANCING

In January 2011, The World Bank and IFC announced that together with local Arab partners the group is supporting renewable energy sources, which should promote the Arab world taking a leadership role in climate change.[30]

Many funds operate in the Arab region in support of development activities throughout the world. Some have dedicated climate change and renewable energy goals, while others are broad. These organizations have an extensive reach in terms of the number of countries they operate in along with the value of their donations.

Most funding through Arab financial institutions goes for development purposes. These funds can be matched with climate funds for EE and RE projects. This shows that there is not a lack of funding in the Arab region, but that the direction, application and implementation of capital should be reassessed to enhance rural development in the Arab countries.

The Arab Fund for Economic and Social Development (AFESD)[31] has a principal purpose to contribute to the financing of economic and social development projects in the Arab countries. The Arab Fund is located in Kuwait, and provides financing for projects by extending loans, on concessionary terms, to governments and public organizations of member states. Projects funded by AFESD are given a preference when they are viewed as vital to the Arab region. AFESD provides various forms of funding including: direct loans, equity investment, guarantees, lines of credits, other financing forms, as well as institutional support and advisory services. In previous work, The Arab Fund has partnered with the International Fund for Agricultural Development (IFAD)[32] for GEF projects[33]. This type of partnership arrangement could be utilized for rural development and electrification projects.

The Arab Monetary Fund (AMF)[34] is a regional organization which was established in 1976 by the League of Arab States (LAS) members. The AMF is located in Abu Dhabi, UAE and its activities include financing deficit payments, promoting and supporting economic reform, developing Arab capital markets, and promoting intra-Arab trade.

The Saudi Fund for Development (SFD)[35] is a bilateral fund designed to finance projects in developing countries by granting loans to countries and encouraging national non-crude-oil exports. The fund does not have a geographic exclusion, and the fund's contributions are provided through soft loans, where it deals directly with governments of the developing countries in financing priority developments projects. The fund does assign priority to least developed and low-income countries.

The Kuwait Fund for Arab Economic Development (KFAED)[36] is a bilateral fund that distributes and manages financial and technical assistance to developing countries, mainly focused on the Arab region. KFAED provides financing in the form of direct loans, grants or guarantees, and

[30] World Bank. *World Bank Highlights Opportunities for Carbon Finance in Arab Countries*: http://climate-l.iisd.org/news/world-bank-highlights-opportunities-for-carbon-finance-in-arab-countries/
[31] Arab Fund for Economic and Social Development. www.arabfund.org
[32] International Fund for Agricultural Development. www.ifad.org
[33] International Fund for Agricultural Development. www.ifad.org/operations/gef/index.htm
[34] Arab Monetary Fund. www.amf.org.ae
[35] Saudi Fund for Development. www.sfd.gov.sa
[36] Kuwait Fund for Arab Economic Development. www.kuwait-fund.org

participations in co-financing operations with other bilateral or multilateral assistance organizations. KFAED also provides technical, financial, economic and legal advisory services on projects, programs and policies, and for the formation of organizations.

The Abu Dhabi Fund for Development (ADFD)[37] is a bilateral fund that administers loans and grants on behalf of the Government of Abu Dhabi and provides economic assistance to developing countries in the form of concessional loans, grants, and equity in investment projects. ADFD primarily supports basic infrastructure projects in transport, water, electricity, and irrigation. ADFD's financial support is directed largely toward Arab and Islamic countries. In 2010 the ADFD announced a joint effort with the International Renewable Energy Agency (IRENA)[38], in setting out selection criteria for disbursing a USD 50 million fund for renewable energy projects to developing countries between 2009 and 2015.[39]

OPEC Fund for International Development (OFID)[40] aims to foster social and economic progress in the developing world through financing for developing countries. OFID is located in Austria and provides funding through public sector loans for development projects and programs, balance of payments support and debt relief.

The Egyptian Social Fund for Development[41] was established in 1991, and is run by a semi-autonomous agency that reports to the office of the Prime Minister. The fund is tasked with mobilizing national and international resources, and integrating governmental bodies, NGOs, and private sector groups for project implementation. According the fund, priority areas include: poverty reduction by supporting community-level initiatives, increasing employment opportunities, and encouraging small-enterprise development.

F. GOVERNMENT FINANCING

Governments are playing a critical role in renewable energy investment. Government funding can come in different forms whether at a local or national level. Whether or not a rural development fund is pursued for co-financing, government support and resources will play a critical role in a projects' implementation. Finance mechanisms launched by the governments should aim to have a direct effect on mobilizing the private sector to engage in renewable energy projects and to build up the market for a sustained commercial activities. Precaution should be made not to cause market distortions that would deter commercial sustainability on the longer run. As private sector engagement is determined by the risk-return calculations, risk distribution through government intervention along with attractive return expectations would break the barriers facing private investors. As the know-how and the market evolve, government intervention would be reduced.

In countries with no energy access problems, feed-in-tariffs, net-metering and/or re-allocated subsidies would have direct effect on market development. Switching to renewable sources would affect rural areas due to the availability of much needed land spaces. As for countries suffering from energy access problems in rural areas, a well-designed micro-financing should be put in place

[37] Abu Dhabi Fund for Development. www.adfd.ae
[38] International Renewable Energy Agency. www.irena.org
[39] UAE Interact. *IRENA to set criteria for US$50 million funding for green ventures.* www.uaeinteract.com/docs/IRENA_to_set_criteria_for_US$50_million_funding_for_green_ventures/39239.htm
[40] OPEC Fund for International Development. www.ofid.org
[41] Egyptian Social Fund for Development. www.sfdegypt.org

where end-user repayments would not exceed high costs of inefficient lighting and heating that are replaced by renewable sources. Micro-financing should also be put in place to boost income generation activities enabling self-sustained economy on the longer run.

On the other hand, high income countries in the GCC have initiated mega projects for renewable energy that include unilateral, bilateral and multilateral investments and programmes. Of these is MASDAR City in Abu Dhabi, United Arab Emirates. MASDAR is funded through private investment and the Mubadala Development Corporation, which is the investment vehicle for the Abu Dhabi government.[42] MASDAR is foreseen to be the main international hub attracting renewable energy and energy efficiency business. Abu Dhabi is thus aiming at becoming a main stakeholder in sustainable energy at the international level while diversifying its economy. MASDAR is expected to cover all of its energy needs, both electrical and thermal, through renewable sources mainly solar PV, concentrated solar power (CSP), waste to energy techniques and geothermal energy.

G. Carbon Markets

Carbon markets are used to address environmental issues by trading credits instead of defining targets for an emission source. Under the UN's Kyoto Protocol emission trading, countries that have emission units to spare or emission units permitted to them but not used can sell this excess capacity to countries that are over their targets.

There are different types of carbon trading; this includes both a compliance market that was implemented based on Kyoto Protocol commitment, and a voluntary market. The compliance carbon market was initiated from mandatory regulations in the Kyoto protocol; in this system, Certified Emission Reductions (CERs) are sold on the compliance market. The voluntary market operates similarly, but Verified Emission Reductions (VERs) or Voluntary Carbon Units (VCUs) can be traded by organizations or individuals that may not have compliance requirements. There is no limitation on governments that participate in the mandatory carbon market from also trading on the voluntary market. Many times while projects are waiting for UN verification, emission units are traded on the voluntary market.

The Clean Development Mechanism (CDM) was introduced through the Kyoto Protocol as a more flexible method to carbon trading and enabling GHG reduction activities. The CDM is a project-based mechanism that promotes emission reductions by having industrialized countries (defined as "Annex I" countries) to finance projects in developing countries. The CDM mechanism gives countries the opportunity to reduce emissions anywhere in the world, typically where the cost is lower than in their own country, and Annex I countries can then count these reductions towards their own targets.

The voluntary carbon market, sometimes referred to as carbon offsetting, is not motivated by international emission reduction commitments, but instead enables organization or even individuals to purchase carbon credits or offsets from activities that have been implemented voluntarily. There is no constraints on what parties can participate in the market, there is a relatively low administrative burden in comparison to the compliance market. There are no universally accepted standards, so the voluntary market is significantly less regulated than the compliance market.

[42] Masdar. *Masdar City*. www.masdarcity.ae

VIII. CHALLENGES FACING THE PROMOTION OF RENEWABLE ENERGY APPLICATIONS IN RURAL AREAS.

Promoting and vast deployment of renewable energy in rural areas can be conducted using national or regional funds from the Arab world when adequate strategies, policies and rules and regulations are put in place. However, major challenges face the execution of such projects and initiatives and the achievement of universal access to modern energy in the Arab world. Achieving sustainability and vast deployment in all rural areas across the region shall overcome the challenges, some of which are listed below:

Government: Includes lack of political support and strategic integrated vision towards rural areas development where different departments compete rather than join hands in moving forward. Lack of dedication to make sure policies are implemented can also hinder the promotion of renewable energy in rural areas. On the other hand, and as the Arab region has faced major changes at the political and leadership levels in the past two years, a major challenge arises related to coping with all the political uncertainties and governance issues taking place currently.

Regulations: Most Arab countries do not have specific targets, policies and regulations related to renewable energy deployment in rural areas. These should be looked at in more details, especially in poorer countries where access to modern energy would have a direct effect on the enhancement of the socio-economic situation in rural areas with its direct effects on the national level.

Local Authorities: The commitment of the local authorities in remote rural areas to enforce the regulations should be examined particularly when the social, familial and tribal interests conflict with the enforcement requirements. On the other hand, many countries in the Arab region suffers from the challenge to enforce regulations, especially following all the political and security unrests that the area passed through.

Institutional Frameworks: Few countries have active and powerful dedicated institutions to cater for rural development. In most cases, rural development is taken care of by departments in ministries with little resources at hand.

Education and Technical Expertise: Technical expertise and knowledge of the different options available with related advantages and disadvantages forms another challenge to adequately deploy renewable energy applications in rural areas. Higher attention should be given to modernize the technical education that would contribute to promote renewable energy applications in rural areas and improve the relevant maintenance services. Moreover, lack of detailed data, such as the level of motor equipment in rural areas would affect greatly the design of a programme and its outcomes.

Consumer Awareness: In most poorer rural remote areas, consumers lack awareness of the effective use of energy for money generation and income increase. The basic needs to be fulfilled would be lighting and cooking as well as heating. Lack of consumer awareness of the opportunities that modern energy can introduce reduces the pace at which access to energy in rural areas can be done. On the other hand, in countries with no energy access problems, lack of awareness about the benefits of renewable energy, combined with the lack of awareness about the non-direct positive impacts of renewable energy on different aspects including health and local economy, would deter the deployment of renewable energy given the upfront cost that have to be paid to get a service already available via conventional energy sources that is heavily subsidized in most Arab countries.

Subsidies: Fuel subsidies existing in most Arab countries as well as electricity subsidies forms the main challenge for the deployment of renewable energy in rural areas. Cross subsidies should be reviewed and/or incentives should be put in place to balance fuel subsidies.

Capital Investment: Larger initial capital costs would deter investors from approaching renewable energy projects especially in rural areas where markets are smaller. Financing mechanisms should be put in place taking advantage of what can be offered by the different donors at the national, regional and international level. Lack of flexible financing mechanisms with simple procedures that could be appropriate to the people in rural areas forms a major challenge for the deployment of advanced energy sources in remote areas.

Household Affordability: Poorer remote areas population face the challenge of affording to pay for the modern energy services that might be accessible. Wood fuel, even if it consumes hours daily to gather and prepare with all the health and other side effect is still seen as available for free. Awareness and capacity building on using spared time and modern energy in money generating activities is needed with a first push support to be able to exit the cycle of extreme poverty.

IX. CONCLUSIONS AND RECOMMENDATIONS

Access to modern energy enhances socio-economic development in remote rural areas. In the Arab world, the least developed countries suffer from very low electrification rate specially in the rural areas. On the other hand, countries in conflict areas suffer from long hours of outages related to the crisis. As for the rest of the Arab countries, more interest is witnessed in deploying renewable energy applications.

Reaching universal rural access to modern energy requires that the governments adopt a holistic approach when designing the country strategies. The approach should take into consideration local needs and benefits as well as local training and support to ensure sustainability of the services provided. It should also address the potentials for renewable energy sources for electricity generation as well as direct applications. In that respect, more emphasis should be made on gathering adequate data, information and statistics on the different application and motive power that can benefit directly from renewable sources. Of these applications for example, agricultural products drying that can use solar energy, and grinding that can use wind and/or hydro run of the river energy. Appropriate technologies and solutions for electricity generation, renewable energy direct applications and cleaner fuels options should be carefully selected based on local needs, conditions and characteristics with a vision for long-term sustainable development.

Other pre-requisites should also be taken into consideration including appropriate policies, regulations, incentives, support mechanisms and industrial capabilities as well as business and market know-how. Financial mechanisms should be coupled with enabling legal and regulatory environment to mobilize the private sector. On the other hand, government programmes should be designed to mitigate risks while kicking-off market dynamics without distorting it through direct involvement.

These pre-requisites would tackle the current challenges allowing to set roadmaps to overcome them. The Moroccan PERG programme is an example of a sound holistic approach that was initiated in 1998 and resulted in quasi universal electrification in rural areas within 15 years. Similar programmes adapted to each country specifics could be initiated with the support of international and regional donors, building on the lessons learned in the ESCWA region.

BIBLIOGRAPHIE

Abu Dhabi Fund for Development. www.adfd.ae

Arab Fund for Economic and Social Development. www.arabfund.org

Arab Monetary Fund. www.amf.org.ae

Clean Technology Fund (CTF) of the Climate Investment Funds (CIF). www.climateinvestmentfunds.org/cif/node/2 (accessed October 10, 2013)

Climate Funds Update. GEF Trust Fund. www.climatefundsupdate.org/listing/gef-trust-fund (accessed October 10, 2013)

Climate Funds Update. Hatoyama Initiative. www.climatefundsupdate.org/listing/hatoyama-Initiative (accessed October 10, 2013)

Development Assistance Committee. www.oecd.org/dac

Egyptian Social Fund for Development. www.sfdegypt.org

Europe Aid. ec.europa.eu/europeaid/index_en.htm

European Investment Bank. www.eib.org

German Development Bank. www.kfw.de

Global Climate Change Alliance. www.gcca.eu

IEA, *World Energy Outlook 2012*

International Climate Initiative. www.international-climate-initiative.com

International Finance Corporation. www.ifc.org

International Fund for Agricultural Development. www.ifad.org

International Fund for Agricultural Development. www.ifad.org/operations/gef/index.htm (accessed October 10, 2013)

International Renewable Energy Agency. www.irena.org

Japan International Cooperation Agency. www.jica.go.jp

Korea International Cooperation Agency. www.koica.go.kr

Kuwait Fund for Arab Economic Development. www.kuwait-fund.org

Masdar. *Masdar City*. www.masdarcity.ae

ONE Web site: http://www.one.org.ma/FR/pages/interne.asp?esp=2&id1=6&t1=1 (accessed October 10, 2013)

OPEC Fund for International Development. www.ofid.org

REN21, *Renewables 2012 Global Status Report*, 2012

Saudi Fund for Development. www.sfd.gov.sa

SODIS website: http://www.sodis.ch/methode/forschung/mikrobio/index_EN (accessed October 10, 2013)

The International Finance Corporation. www.ifc.org

UAE Interact. *IRENA to set criteria for US$50 million funding for green ventures*. www.uaeinteract.com/docs/IRENA_to_set_criteria_for_US$50_million_funding_for_green_ventures/39239.htm (accessed October 10, 2013)

UNDP, WHO, *The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa*, 2009

UNHCR website: http://data.unhcr.org/syrianrefugees/set_language.php?Code=AR (accessed October 10, 2013)

United Nations Development Programme. www.undp.org

United Nations Environment Programme. www.unep.org

United Nations Industrial Development Organization. www.unido.org

United States Agency for International Development. www.usaid.gov

United States Trade and Development Agency. www.ustda.gov

World Bank. *World Bank Highlights Opportunities for Carbon Finance in Arab Countries*, http://climate-l.iisd.org/news/world-bank-highlights-opportunities-for-carbon-finance-in-arab-countries/ (accessed October 10, 2013)

World Bank. www.worldbank.org